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United States Department of Agriculture
Agricultural Research Administration
Bureau of Entomology and Plant Quarantine

USE OF INSECT REPELLENTS AND MITICIDES 1/

By B. V. Travis and F. A. Morton
Division of Insects Affecting Man and Animals

During the last several years thousands of chemicals have been tested to determine their value in repelling various kinds of insects. Out of this large number a few new repellents and miticides have been developed which give effective protection from the bites of mosquitoes, punkies (no-see-ums), black flies and other biting flies, and chiggers, or red bugs (mites). Unlike the older repellents, these materials have little or no odor and they remain effective from two to several hours even when these insects occur in large numbers. This circular gives information on the availability, use, and effectiveness of these insect repellents and miticides. Although they were developed primarily for military use, they can also be used safely by civilians.

Formulations

The following available repellents are effective and safe when used individually or in combination: Dimethyl phthalate, Dimethyl Carbate (cis-bicyclo[2,2,1]-5-heptene-2,3-dicarboxylic acid, dimethyl ester), Indalone (n-butyl mesityl oxide oxalate), and Rutgers 612 (2-ethyl-1,3-hexanediol).

These chemicals vary greatly in their effectiveness against different insects and on different individuals. Certain materials which are satisfactory against some species may fail to repel others. Laboratory and field tests have shown that the following mixtures of repellents are effective against a wider range of insect species and on more individuals than any one of the chemicals when used alone.

Formula 1	Formula 2
Dimethyl phthalate - 3 parts 2/	Dimethyl phthalate - 1 part
Indalone ---------- 1 part	Indalone ---------- 1 part
Rutgers 612 -------- 1 part	Rutgers 612 -------- 1 part

1/ The data included in this paper were obtained in connection with investigations conducted under a transfer of funds, recommended by the Committee on Medical Research, between the Office of Scientific Research and Development and the Bureau of Entomology and Plant Quarantine.

2/ All parts by weight.

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Formula 3

Dimethyl phthalate - 3 parts
Indalone ---------- 1 part
Dimethyl Carbate --- 1 part

Mixtures containing two repellents are also fairly effective, but these do not repel so wide a range of insects or for so long periods as do the triple mixtures. Examples of such mixtures are:

Formula 4

Dimethyl phthalate - 2 parts
Rutgers 612 -------- 1 part

Formula 5

Dimethyl phthalate - 2 parts
Dimethyl Carbate --- 1 part

Some of the repellents that are now offered for sale under proprietary or trade names contain only a small percentage of the active ingredient and a large percentage of alcohol or some other diluent. Although such materials have physical properties that make them more acceptable cosmetically, the period of protection is much reduced by the addition of the diluent. For maximum protection the chemicals should not be diluted with inert materials.

Effect of Application to the Skin

These chemicals and their mixtures have been tested by toxicologists and have been found safe for use as skin applications. They are toxic if taken internally. Other chemicals have shown marked repellent qualities, but they cannot be recommended because of their irritating properties. Occasionally there are people who are allergic to certain of the materials that have passed toxicological tests. It is possible that a few persons may show slight rash or other minor skin reactions to some of the repellents. Any of the effective and toxicologically safe repellents may cause some "smarting" when applied to the mucous membranes and to areas where the skin is especially tender, such as the eyelids or groin region or where there are skin abrasions. Care should be taken not to apply any of the approved materials too liberally on the forehead or eyelids, as they cause a rather severe but temporary stinging if they get into the eyes. There will be a period after application when the treated skin will feel quite warm, especially if the skin is moist with sweat. Ordinarily, the sensation lasts for only a few minutes and causes no injury.

Effect on Paints, Plastics, and Other Synthetic Materials

All these repellents are solvents of paints, varnishes, and many of the plastics. They must be used with caution, as they will damage such materials as plastic watch crystals, synthetic cloth (sharkskin, rayons, etc,) fingernail polish, and articles that are painted or varnished or made of plastics. These chemicals will not damage cotton or wool cloth if such cloth contains no synthetic fibers.

Use Against Mosquitoes, Flies, and Biting Gnats

Repellents must be uniformly distributed over the area to be protected. Otherwise the insects will seek out and bite in any small area where the repellent was not thoroughly applied.

Applications to skin.-- All these repellents feel oily on the skin and for this reason may be objectionable to use. However, materials of this type give more complete and longer protection than do the less viscous materials, which either evaporate or are absorbed shortly after application. Because the conditions of use are variable, the only rule to follow is to apply when the insects resume biting on the treated areas. Under favorable conditions one treatment may last several hours on some people, and not so long on others.

The most common method of using repellents from the bottle is to shake a few drops into the palms, smear evenly, and then apply thoroughly to the backs of the hands, wrists, neck, ears, face, or any other exposed skin, much as in washing. This procedure should be repeated until a uniform oily film is applied.

Applications to clothing.-- In some localities mosquitoes cause considerable annoyance by biting through clothing. Under such conditions repellents may be sprayed or daubed on clothing where the bites occur. This treatment may be expected to last several days if the clothing remains dry. One soaking with water, however, removes enough of the repellent to make treated clothing non-effective. (See Effect on Paints, Plastics, and Other Synthetic Materials).

A simple method of applying repellents to clothing is to shake about a dozen drops of the repellent from the bottle into one hand, rub the hands together, and rub lightly on socks, shirts, or trousers where bites occur. Repeat this procedure until the areas to be treated have been covered. The repellents may be applied to the clothing also with a small hand sprayer. Spray lightly the areas where the insects are biting through the clothing.

Use Against Chiggers or Red Bugs (Mites)

Any of the insect repellents will give protection from chigger bites if properly applied. The action on chiggers is largely as a toxicant, which kills them, rather than as a repellent. The materials should be applied to the clothing and not to the skin. In addition to the chemicals mentioned, benzyl benzoate is very effective as a miticide and is preferred because of its physical characteristics, effectiveness, availability, and cost. Although dimethyl phthalate is comparable in these respects, benzyl benzoate is the better of the two chemicals as it will withstand laundering. Retreatment is necessary after two ordinary home launderings, whereas dimethyl phthalate must be re-applied following each laundering or following a soaking from heavy rain or from wading in water.

The methods of applying these chemicals for protection against chiggers vary according to the needs of the individual.

Hand application.-- The best and simplest method for the individual to treat his own clothing is to pour about a dozen drops of the miticide into one hand, rub the hands together, and then rub lightly on the socks and other clothing. The most liberal applications should be made along all openings of the clothing, such as inside the neckband, and the fly and cuffs of trousers.

Barrier method.-- With the barrier method the materials are applied only to the openings of the clothes--inside the neckband, fly, and cuffs of shirt; inside the waistband, fly, and cuffs of trousers; and on the socks both above the shoes and inside, below the tongue. The material may be applied by daubing as described above, with a sprayer, or by drawing the mouth of the bottle along the cloth to apply a thin layer one-half inch wide. Women's clothing may be protected in the same general way.

If one is not going to be crawling about on the ground, nearly complete protection can be obtained by smearing the miticide only on the socks above the shoe tops and on the bottoms of the trouser legs.

Spray method.-- The material may be applied to the clothing by the spray method described for protection from mosquito bites, except that special precautions should be taken to spray the openings to the clothes.

Immersion method.-- Complete protection can be had on field clothes by immersing them while dry in a water emulsion of the miticide. Either dimethyl phthalate or benzyl benzoate, preferably the latter, may be used. Although satisfactory emulsions can be made with soap,

the most practical method is to prepare a concentrate by dissolving one of the following emulsifiers in the miticide, using 10 parts 2/ of the emulsifier to 90 parts of the miticide: Stearate 61-C-2280 (a polyalkylene glycol stearate); Tween 60 (sorbitan monostearate, polyoxyalkylene derivative); Tween 80 (sorbitan monooleate, polyoxyalkylene derivative); polymerized glycol monostearate, monooleate, or monolaurate; Span 60 (sorbitan monostearate) and Tween 60, equal parts; Span 80 (sorbitan monooleate) and Tween 80, equal parts.

The final emulsion in which the clothing is dipped can be prepared by adding ½ pint of the concentrate to 1 gallon of water. It is best to agitate vigorously 1 part of the concentrate in 2 or 3 parts of water to form a creamy emulsion and then dilute with the remainder of water, using moderate agitation. One gallon of emulsion is sufficient to dip a set of field trousers, shirts, and socks. After dipping, wring out the garments lightly and dry before wearing.

Sources of Materials

The following list of firms which may supply the materials mentioned above is given for the information of the reader. It does not include all firms, and no discrimination is intended or implied for names omitted, nor is warranty given as to the grade or standard of the product of these firms.

Finished Repellents and Mixtures

Skol Co., Inc., 250 E. 43rd St., New York, N. Y.
Carbide and Carbon Chemical Corp., 30 E. 42nd St., New York, N. Y.

Repellents

Dimethyl phthalate

Practically any large chemical firm.
Fred L. Brooke Co., 228 N. La Salle St., Chicago, Ill.
Carbide and Carbon Chemical Corp., 30 E. 42nd St., New York, N. Y.
Commercial Solvents Corp., 17 E. 42nd St., New York, N. Y.
C. P. Chemical Solvents, Inc., 60 Park Place, Newark, N. J.
Doe & Ingalls, Inc., 50 Garden St., Everett Station, Boston, Mass.
Heroules Powder Co., 978 Market St., Wilmington, Del.
Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo.
Phillips & Jacobs, 620-22 Race St., Philadelphia, Pa.
Reichhold Chemicals, Inc., 601 Woodward Heights Blvd., Detroit, Mich.
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.
U. S. Industrial Chemicals, Inc., 60 E. 42nd St., New York, N. Y.

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Dimethyl Carbate

Carbide & Carbon Chemical Corp., 30 E. 42nd St., New York, N. Y.
American Cyanamid & Chemical Corp., 30 Rockefeller Plaza, New York, N. Y.
Gallowhur Chemical Corp., 250 E. 43rd St., New York 17, N. Y.

Indalone

U. S. Industrial Chemicals, Inc., 60 E. 42nd St., New York, 17, N.Y.
Kilgore Development Corp., 1050 - 30th St., N. W., Washington, D. C.

Rutgers 612

Carbide & Carbon Chemical Corp., 30 E. 42nd St., New York, N. Y.

Benzyl benzoate

Practically any large chemical firm.
American Firstoline Corp., 420 Lexington Ave., New York, N. Y.
P. R. Dreyer, Inc., 119 W. 19th St., New York, N. Y.
E. I. du Pont de Nemours & Co., Inc., Wilmington 98, Del.
Merck & Co., Inc., 100 Lincoln Ave., Rahway, N. J.
Monsanto Chemical Co., 1700 S. 2nd St., St. Louis, Mo.
Clarence Morgan, Inc., 929 N. Michigan Ave., Chicago, Ill.
Ashcraft Wilkinson Co., Atlanta, Ga.

Emulsifiers

Stearate 61-C-2280

Carbide & Carbon Chemical Corp., 30 E. 42nd St., New York, N. Y.

Spans and Tweens

Atlas Powder Co., 9th and Market Sts., Wilmington 99, Del.

Polymerized glycol monolaurate, monostearate, and monooleate

Glyco Products Co., 26 Court St., Brooklyn, N. Y.